CONSIDERING TELECOMMUNICATIONS FOR ALL TRIP TYPES IN A METROPOLITAN REGION'S TRANSPORTATION MODEL

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Incorporating the effects of telecommunications on metropolitan area vehicle movement could potentially include all of the ways that physical movement patterns are changed by the growing electro-optical movement of information over distance. Such patterns of physical movement include the number of trips, their timing, their origins and destinations and thus trip length, their routing over the road network, and the mode of travel. Specifically:

Trip volume: Telecommunications can be a substitute for a trip in the case of telecommuting, teleshopping, and telelearning. Or telecommunications can be the generator of trips, by creating a wider focus of attention that creates awareness of new places to visit and new people to meet, or by making travel time more productive. As described in *Beyond Telecommuting* (US DOE, 1994), the list of ways in which telecommunications increases trip-making is just as long as the list of ways in which it decreases trip-making.

Trip timing: Telecommunications can also cause trips to be made at different times, perhaps avoiding peak periods. Telecommuters and other home workers with flexible schedules have more opportunity to do some necessary errands during off-peak periods, and stay at home during the morning and evening rush. On the other hand, just-in-time delivery services like Federal Express, which are very much enabled by the technology and habits of the information age, generate vehicle traffic in evening rush hour in order to meet the deadlines that are part of their rapid service.

Trip Length: Telecommunications can change the length of trips, making them either longer or shorter. For example, an on-line information system could be designed to describe the nearest place to purchase a needed item, promoting purchase there rather than driving to a familiar place that is farther away. Telecommuting applications affect trip distribution, because of the long-run propensity of workers to choose residential locations based on the journey-to-work pattern. Consistent

worker location data implicate telecommuting as a source of metropolitan sprawl, because people can now exercise residential preference without a long daily commute to a central office during peak traffic periods. The weekly trip to the supermarket, however, could be a much longer trip for a person living in a rural region surrounding a metropolis. If the number of residents in an exurban region grows and a new grocery store locates there, then the daily commute for workers at that grocery store could be longer than average.

Trip routing: Telecommunications can furthermore cause the route of a trip to change. Good information about traffic conditions generated by Advanced Traveler Information Systems can be the motivation for staying off of a crowded corridor in peak, or driving into a crowded corridor that would typically be avoided in the absence of an information system that can now reveal that the traffic is free-flowing.

Travel mode: Finally, telecommunications can cause the mode of travel to change. An information system that provides accurate, real-time information on the exact time when a bus will arrive at a nearby bus stop, or a system that enables buses to make front door pickups, could cause more people to ride the bus rather than use their private automobiles. Teleworking in the broadest sense, however, is likely to make mass transit and ridesharing relatively less appealing than private vehicle modes, because of the prospect of changes in economic structure, business processes, and land use in the direction of more temporary employment, just-in-time behavior, and geographic dispersion.

All of these aspects of telecommunications are considered in the sum of steps that make up the existing "four step" transportation model of Metropolitan Planning Organization (MPOs). As a quick review, the four steps of a transportation model, executed in this order, are:

Trip generation by trip type across each transportation analysis zone into which the metropolitan region is divided. The time-of-day of each trip generated, peak or off-peak, is included here as well.

Trip distribution that allocates all trips across and within the zones based upon origins and destinations of trips.

Mode choice that allocates trips across automobile, transit, and other modes.

Trip assignment that allocates all trips across specific freeways and arterials in the region's transportation network.

The remainder of this paper will focus simply on trip volume effects of telecommunications, primarily substitution, which is of public policy interest. In popular but somewhat inaccurate terms, this is the analogy of telecommunications acting as a mode of transportation. The story is a little more complex than this analogy implies, as we shall describe.

In consulting assignments for two MPOs, the Southern California Association of Governments

and the Puget Sound Regional Council, Ellen Williams & Associates in association with Global Telematics took the approach of classifying by trip purpose that subset of telecommunications applications having an impact on physical movement. Such a classification is presented in the table below, which is an abridged version of Exhibit 11 in the *Southern California Telecommunications Deployment Strategy*, prepared by the Southern California Association of Governments in 1996.

Linking Trip Purposes to Telecommunications Applications

	high	
Travel destination		Networked electronic classrooms and libraries
	medium	
Place of daily work		Remote consultation, monitoring, treatment
	medium	
Shopping malls		Pre-visit qualification, electronic post-visit interaction, literature on line
	medium	
Off-site work meetings		Electronic ordering and home delivery
	low	
College campuses and high schools		Enticing, in-home alternatives to going out
	low	
Medical offices		Remote access to documents, services, hearings
	low	
Customers & prospects in the field (industrial & business sales)		ATMs, electronic transactions, loans by phone
	low	
Grocery stores		Electronic listings, video interviews
	low	
Cinemas, video rentals, arcades		On-line photos, electronic signatures
	low	
Government buildings		
	low	
Banks, financial services		
	low	
Prospective employers, employment services		
	Telecom applications for trip saving	
Houses for sale with listing agents		
	Telecommuting	
Estimated relative share of daily trips		
	Teleshopping	
high		
	All modes of teleconferencing	

As a first problematic comment on the list of applications in the table, we note that most MPOs model only a few, predominant trip types. At present, one of the two West Coast MPOs mentioned above models only commuting trips and shopping trips in their transportation planning, while the other MPO also includes school trips.

A next step in considering telecommunications effects on transportation is to assign mobility-influencing telecommunications applications into a framework that can be used in the overall transportation modeling process. Consultants' preliminary judgment on approaches for modeling telecommunications within the present four-step framework are as follows.

Approach One: Telecommunications Implicit in Present Model

The first approach assumes that many applications of telecommunications require no explicit consideration because the travel impacts of them are already incorporated into the transportation model via the MPO's existing periodic monitoring of travel characteristics. Telecommunications has been underway for many decades, and thus is built into today's travel patterns. If the MPO's baseline trip generation estimations are functions of travel volume influences such as numbers of people, households, workers, and vehicles per household, then telecommunications usage that either increases trips or decreases trips may be well reflected in changing coefficients in the equations that would show up over time as the equations are calibrated to the real world.

For example, consider the use of telecommunications as a substitute for meetings. Society is in the middle of a gradual evolution in the use of telecommunications as a way of meeting, an evolution that began with the growing use of telephones in the 1920s. Electronic mail came along later, and video conferencing more recently. These technologies are reaching use gradually and are fully encompassed in travel trend data that is used to create and calibrate present trip-generation models. When the model's trip generation equations are calibrated to actual trip generation measurements, the effect of many telecommunications applications is implicit in the changing coefficients applied to the demographic variables, in that same sense that economic growth and land use patterns are built in.

Another argument for claiming that telecommunications is implicit in the trip generation equations lies in the complex of ways in which telecommunications act on travel behavior. Considering just trip substitution, we can see at least five different mechanisms at work:

> **Equivalent functionality:** The main method of trip elimination is that telecommunications lets people achieve enough of the functionality of going to a place without actually having to go there. Sufficient functionality is achieved from a distance by telecommunications allowing observation, transactions, communications, and information exchange. The use of telecommunications as a substitute for travel is called telesubstitution. Instead of driving to work, a worker stays home and telecommutes. Instead of registering for university classes on the campus, a student registers over the telephone.

Pre-travel verification: In addition to providing opportunities for telesubstitution, telecommunications also lets people call ahead to find out if the trip is or is not worth making. As a simple example, instead of driving around to a variety of stores looking for a particular item to purchase, a shopper phones to a number of stores until the item is located, and then drives to one store directly. This effect is closely related to telecommunications changing the length of trips.

Knowledge of travel conditions: Accurate, up-to-date knowledge of conditions at the destination or on the journey can cause trips to be canceled as unnecessary with perhaps teleconferencing or other telesubstitution used instead of face-to-face presence. Joining the meeting by telephone is not so bad if the only freeway leading to the site of the meeting is blocked by an accident. This effect is closely related to the effect of telecommunication changing the timing or route of a trip, as discussed above.

Process reengineering: Going beyond decision making by individuals, telecommunications allows the revision of organizational operations to eliminate passenger and freight trips that raise costs unnecessarily. Instead of a soft drink delivery truck driving to a heavily used Coke machine once every two days to fill it up (whether needed or not), wireless radio status reporting on the contents of the machine allow the bottler to visit as needed, which results in visits that calculate out to one visit every 3.3 days.

Lifestyle patterns: Going beyond direct functional substitution, a fifth source of travel saving comes from telecommunications providing opportunities to change leisure, recreational, and personal activity toward patterns that generate fewer trips. An example here is members of a household more frequently staying home to surf the Internet rather than going out to see a movie at the cinema.

The modeling requirement for the out years is to estimate future changes in coefficients, perhaps based on past trends in the changing of those coefficients.

Approach Two: Overlay Outside the Model

A second approach to modeling telecommunications would be to include certain telecommunications applications in the modeling process through external processing outside of the flow of existing calculations in the model. Some telecommunications applications are not related to the existing variables in the modeling process. Other applications fall into this approach because the forecasting methodology is completely different from the one used in the regional transportation model. The Southern California Association of Government's present methodology of taking telecommuting and working at home as separate, outside, across-the-board overrides on the baseline trip generation stage of the model falls into this second approach. The caveat is that some applications of telecommunications can work to stimulate more trips as well as reduce trips. Given that the MPO's traffic model is aimed at summarizing all forces that bear on trip making, simply isolating the trip reduction side of

telecommunications and applying it as an override on the trip generation baseline should be used with caution.

Approach Three: Explicit Incorporation Into the Model Steps

A third approach covers telecommunications applications that should be explicitly included in a particular appropriate step in the traffic forecasting process. This methodology would work where the application can be put into a transportation framework. Telecommunications applications incorporated under this approach must be assessed to determine which variable in the existing model represents their effect on travel. For example, occasional telecommuting from home might be incorporated as an additional mode in the modal choice step of the model. Some of the applications may affect more than one step in the modeling process, but most would affect the trip generation stage of modeling.

These three approaches are all ways of extending the traditional four stage transportation modeling approach to include the effect of telecommunications on all trip types. As the Travel Model Improvement Program goes forward, the daunting challenge will be to determine whether the structural effect of telecommunications causing trip replacement, trip generation, and other changes in travel characteristics can be incorporated into a new generation of models.